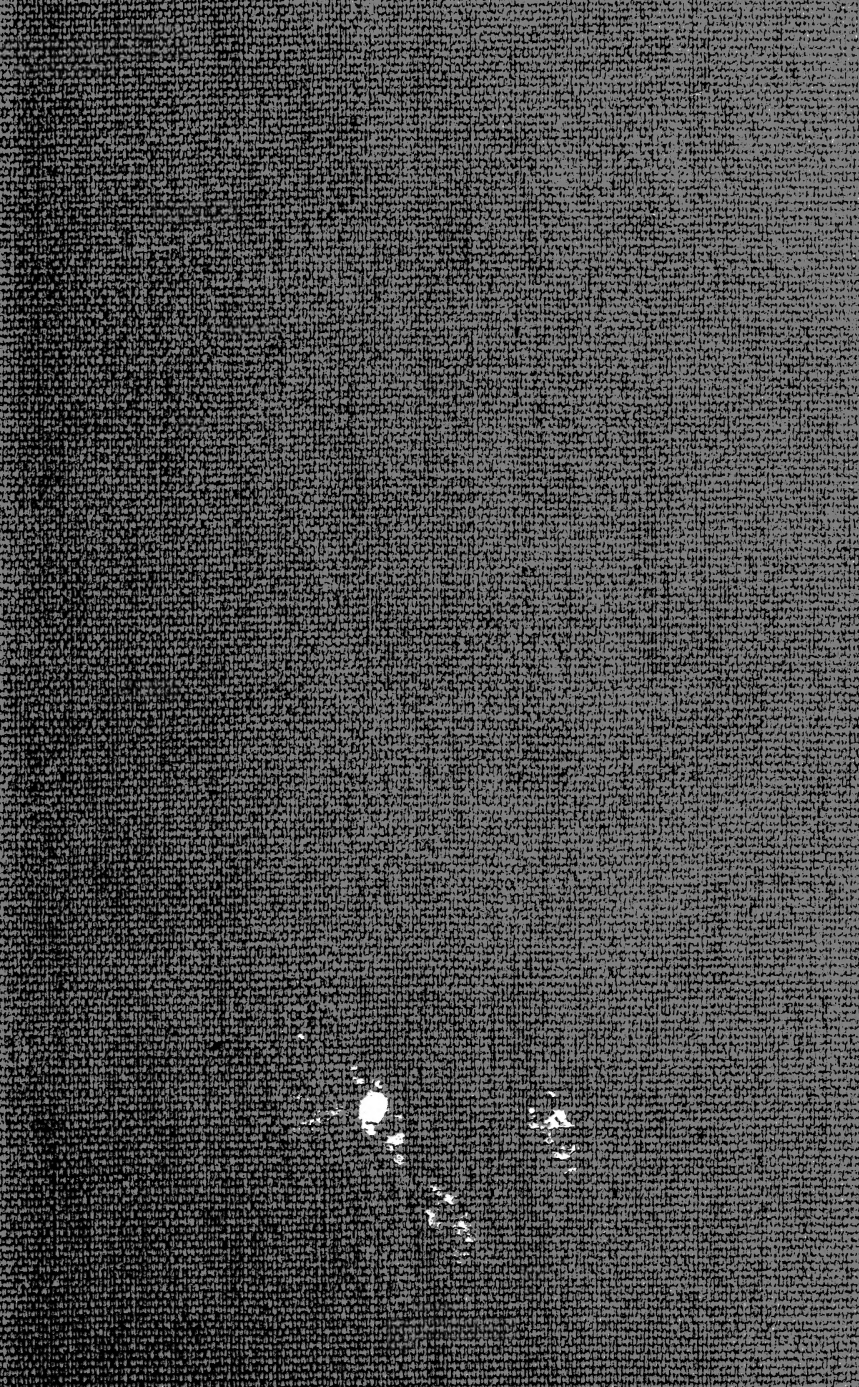

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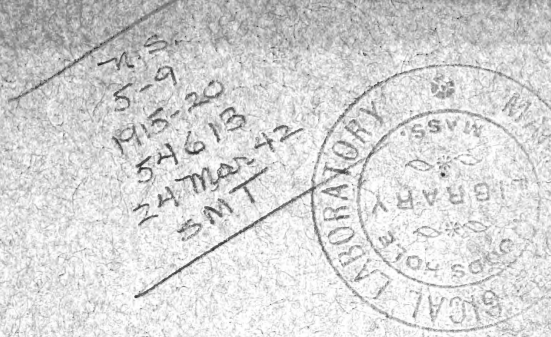

DOVE MARINE LABORATORY,

Cullercoats, Northumberland.

REPORT

For the Year ending June 30th, 1916.

EDITED BY ALEXANDER MEEK,

PROFESSOR OF ZOOLOGY, ARMSTRONG COLLEGE, IN THE UNIVERSITY OF DURHAM,

AND

DIRECTOR OF THE DOVE MARINE LABORATORY.

Published by the Marine Laboratory Committee of Armstrong College on behalf of the Northumberland Sea Fisheries Committee and other contributing authorities.

New Series, V.

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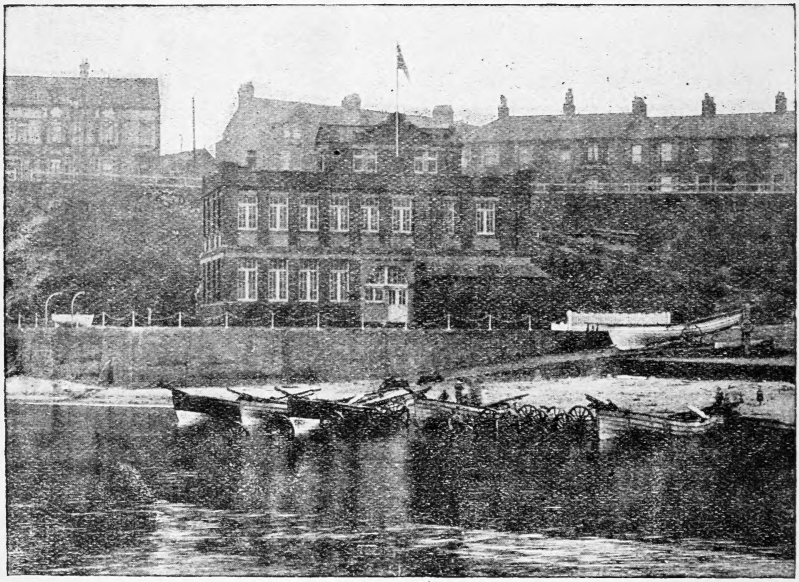

DOVE MARINE LABORATORY, CULLERCOATS.

SUMMARY AND GENERAL REPORT.

As in the previous year the work this year has been restricted to investigations made in the Laboratory and at North Shields.

Resulting, however, from the marking experiments of 1912 relating to the crab, an example was returned from Banff which is of peculiar interset. It was absent about three and a half years, and thus indicates the relationship of ecdysis to growth and the maturation of the ovaries, and through the last the association of all with migration.

In spite of the adverse conditions, our fishermen landed herrings at North Shields, and the opportunity was taken to continue our investigations. The samples were examined as before by Mr. Storrow, and are of value since they have yielded additional information with regard to the Northumberland and trawl caught schools.

A peculiar feature in herring investigation with relation to growth has attracted general attention. It is that when the attempt is made to calculate the growth of the herring from the relative distance of the winter rings from the centre of the scale, the resulting figures form a descending series in the successive year groups. This problem is discussed, and it has been found that when the actual size is contrasted with the calculated it is greater during the period of the formation of the first two winter rings, is about equal at the third, and is greater after the third winter ring. It is evident therefore that since the scale appears only after the herring reaches a size of about 4 cm. it grows more rapidly than the fish. It is not as has been suggested therefore due to selection, but to a want of correlation between the growth of the scale and the fish, a want of correlation which is probably generally true.

Experiments were made in the feeding of lobster larvae, as a result of which it is evident that a crustacean diet is most suitable. It was found also that in addition to movement of the water, shelter was of benefit in rearing the larvae.

The bait resources of the district have been considered, and the conclusion is that while many different kinds of bait are used according to the circumstances of each station, the men mainly rely on mussels imported into the district. As our experiments at Fenham Flats have demonstrated that the area could easily supply the district with all the mussels required, we are endeavouring to get the Scaup covered by the work of a number of the men at Holy Island. When this scheme is fairly under weigh, it might be desirable for those interested in the fisheries of the district to have a meeting on the spot with the fishermen to see what could be done to develop it on a firm commercial basis.

Mr. Storrow has made a series of valuable investigations on the age and growth of several species of fish which have been caught in the district, based on an examination of the scales and otoliths. The investigations add materially to our knowledge of the growth of fishes.

He also gives notes on the occurrence of several fishes in the district and from the region to the north. It is interesting to note the presence in the summer of large mature Argentines, and these will more than probably turn out to be spent fish making a denatant feeding migration.

The " Evadne " was returned from the Admiralty in June, but we do not intend to use her for investigations at sea this season.

A. MEEK.

14th July, 1916.

MIGRATION OF CRABS.

By ALEXANDER MEEK.

The results of the marking experiment of 1912 have been very successful, as has been manifest from the preceding reports. The crabs were marked with characteristic care in the last three months of 1912 by the late Mr. John Douglas, Beadnell. Forty-one females were recaptured, and in nearly every case they had migrated northwards, the majority having reached Scottish waters.*

This year, thanks to Dr. T. W. Fulton, of the Scottish Fishery Board, we received No. 257, a female marked and liberated on October 16th, 1912, at Beadnell. It was caught, presumably in a cod-net, on March 16th, 1916, one mile off Banff, a distance of about 160 miles from the place of liberation. It measured across the carapace 18 cm. (7 ins.). This example has been absent therefore for 3 years and 5 months. The specimen presents several interesting features.

It was a berried female. This is the first time that a berried crab has been returned in connexion with the marking experiments. The berried crab is not often caught in a crab pot, and this is due likely to the great distention caused by the enormous mass of eggs, and also probably to a disinclination to feed. The eggs had been recently spawned, for development was only slightly advanced. The spermathecae were found to be empty.

The next point is that the cuticle or shell had been retained for a period of nearly four years. There is now abundant evidence from the Northumberland experiments of the variability in the periods intervening between successive ecdyses, and the probable cause of the retention of the cuticle has been discussed in previous reports. It is not likely in this case that the usual routine had

* Reports, Dove Marine Laboratory, New Series, II., 1913, page 13; III., 1914, page 73, IV., 1915, page 40.

been departed from. The ecdysis and the pairing took place in 1912, and the ripening of the ova and their fertilization early in 1916. An inspection of previous reports on this subject will indicate that crabs may come into berry (*a*) after the lapse of a year and some three months, (*b*) after two years, and (*c*) after three years from the time of the ecdysis. The ecdysis in each case follows normally the hatching of the eggs. Thus in the cases just cited ecdysis would take place at the end of two, three and four years respectively.

As soon as the female becomes mature ecdysis is postponed for a year. This condition is brought about by reproduction reacting on growth. But it is evident that as the rate of growth declines reproduction is obliged to wait on growth. This is a causal relationship of the greatest interest.

I wrote with reference to the lobster in 1912,* "It is plain also with regard to the female that while at the onset of maturity reproduction regulates ecdysis, the balance between growth and ecdysis is restored after a few years when two or three ecdyses have taken place. After that period ecdysis regulates spawning, that is to say, when a size is reached when it is not possible to complete sufficient growth to enable casting to take place biennially." These remarks apply equally well to the crab, and it is gratifying to find from the results of successive experiments more and more evidence of the fact.

From the facts which have been advanced it will be granted that there is this relationship between ecdysis and growth, and indeed the necessity for it may be said to be apparent. It is more difficult to prove that growth and ecdysis are also related to the ripening of the ovary, that the ripening cannot take place until some somatic relationship of growth in relation to ecdysis has been satisfied. It might be urged that exceptions to the usual procedure have been recorded. It has been pointed out, for example, that lobsters may become twice berried without casting. The examples which have been quoted are few, and the proof has not been adequate. On the other hand, however, all investigators have

* Report, Dove Marine Laboratory, New Series, I., page 38.

come across specimens which in tank conditions have not cast in the same season in which hatching took place. The exceptions may be said to point to a relative independence of the germ cells, but the fact that the procedure which has been sketched above is almost universally followed indicates clearly that there is an inter-relationship between the three processes. The point receives corroboration from a consideration of the migrations.

It may be said, as was pointed out in a previous report,* that it is generally true the shorter the migration to the north the less the time. But it is evident when the results are inspected in detail that migration is related to reproduction. For example, in the present experiment, No. 172 migrated to about the same region, Banff, in $8\frac{1}{2}$ months. The example now described took nearly $3\frac{1}{2}$ years. Many recaptures have been made at Dunbar and the neighbouring coast two or three months after liberation. On the other hand, No. 428 was caught at Dunbar after being free about two years and four months. Many more instances of the same kind could be quoted from our experiments to prove that while in the same season a time-distance relationship is probable the impulse is concerned with the periodical ripening of the ovaries.

The distance of the migration of the mature females may be said to vary from 20 to 150 miles, and in all cases the distance may be covered in one season. The variability in this respect is probably due to the degree of the impulse. So far as our records can guide us only large crabs migrate to the further limits. The number of the ova and the size of the ovaries increase with age. The development of these probably requires a longer time in the older crabs, and there may be a relationship between the time and degree of development of the ovary and the time and distance of the migration. If there is, as in every probability there is, an internal secretion concerned in the impulse it probably increases with the increase of the organ.

It is becoming evident therefore that growth, ecdysis, reproduction and migration are all intimately associated.

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* *Loc. cit.*, 1913.

It has been frequently pointed out before that the migration of the female crabs to the north is correlated with the drift of the larvæ to the south. It is evident from what has already been said that the larvæ will come to rest all along the coast to the south. As the young crabs grow they probably migrate into the regions of the coast in which they mainly abound, or are preserved in such regions which afford them protection and food. At all events, while we know they annually migrate out and in with relation to the coast they do not do so in the manner which accounts for the distribution of dabs and plaice for example.* The crab illustrates well the general principles of migration with relation to current. Denatation is usually followed by contranatation at maturity.

* Report, Dove Marine Laboratory, New Series, III., page 29.

THE SCALES OF THE HERRING AND THEIR VALUE AS AN AID TO INVESTIGATION.

By ALEXANDER MEEK.

Investigators are still divided as to the utility of the scales of the herring in determining age and growth. It is not that there is any real disagreement as to the fact that the winter rings are duly recorded, but that in the minds of some the secondary concentric rings are liable to be confounded with the annual rings, and that because of this the method is not to be depended upon. If the feature of indistinctness be of general occurrence and such as cannot be overcome by experience in manipulation and lighting, it is evident that the results would be practically worthless. Different workers would arrive at different conclusions, and the same worker might read the same sample with divergent results at successive observations.

It is important to observe, however, that samples of scales are found which are perfectly clear and consistent, and the proportion of these to the total number of the sample of herrings will determine how far the method may be utilised. Many investigators have found that the majority of the samples are of this description, and this has been our experience at Cullercoats. In most cases we have found the winter rings to be quite distinct, and only a few examples have been met with which presented any difficulty. If workers content themselves then with the certainties and neglect the others, the method loses little in value. It will still be possible to indicate the growth and the differences in age composition of the samples, and thus to distinguish the schools. Experience will also lead to a gradual lessening of the percentage of the samples which appear to be doubtful.

The scales are not merely of value in determining the age of the herring and the age composition of the samples, but as has been shown by Lea and Dahl and their successors the relative distances of the successive winter rings from the centre of the scale allow of the calculation of the size of the herring at the

period of formation of each winter ring. It has been found, however, and not without some degree of misgiving, that when the growth of the herring is thus expressed in terms of the growth of the scale the calculated sizes at each winter ring form a descending series with age. It is to a consideration of this apparent contraction in size that this paper is mainly directed.

The anomaly will be best understood by giving an example, Table I.:—

TABLE I.—Summary of Calculated Sizes in Centimetres of Samples A—L, Northumberland School, 1913.

Number of Herrings.	Winter Rings. 1		2		3		4		5	
	Range.	Mean.	Range.	Mean.	Range	Mean.	Range.	Mean.	Range.	Mean
166	7·16-13·9	10·9	16·3-22·4	19·9	—	—	—	—	—	—
688	5·5-14·0	9·2	12·1-22·0	17·2	18·3-25·4	21·9	—	—	—	—
419	5·0-14·4	8·4	11·3-21·5	16·0	18·2-25·3	21·3	21·0-27·5	23·7	—	—
85	5·9-12·3	8·2	12·3-21·2	15·8	17·3-25·1	21·1	20·4-26·6	23·7	21·7-27·6	25·2

It will be seen from the table that the mean calculated size appears to suffer contraction in each successive year group, and it will be noted that the shrinking in size particularly characterises the results during the period of formation of the first three winter rings.

Other examples will be found in the paper by Lea, and the tables he gives also show that the apparent contraction takes place even when the attempt is made to follow the successive year groups in successive years. In other words, the apparent change in the rate of growth is not confined to one sample nor to the samples of one season.

With a view to obtaining the necessary information for contrasting the growth of the scale with the growth of the herring measurements have been made of the scales of two samples of herring. Sample 7 was obtained on July 20th S.E. of the Tyne, and sample 8 on July 27th, 1914, N.E. of the Tyne. In Table II. the sizes of the scales are given, and in Table III. the sizes at each winter ring as calculated by the method now under review.

TABLE II.—Summary of Sizes of Scales and of Size of Scales at each Winter Ring in mm. in Samples 7 and 8.

Sample 7.

Number of Herrings.	1		2		3		4		5		6		Scale.	
	Range.	Mean.	Range.	Mean.	Range.	Mean.	Range.	Mean.	Range.	Mean.	Range.	Mean.	Range.	Mean.
2	2·5-2·9	2·7	—	—	—	—	—	—	—	—	—	—	3·65-4·0	3·8
112	1·1-2·4	1·77	2·1-4·2	3·39	—	—	—	—	—	—	—	—	3·4-4·75	4·04
117	0·78-2·1	1·44	2·1-3·95	2·81	3·05-4·6	3·72	—	—	—	—	—	—	3·45-5·2	4·21
8	1·1-2·05	1·61	2·5-3·5	3·02	3·3-4·3	3·87	3·9-4·8	4·29	—	—	—	—	4·15-5·1	4·49
2	1·4-1·7	1·55	2·6-3·0	2·8	3·2-3·85	3·58	3·7-4·5	4·1	4·1-4·7	4·4	—	—	4·2-4·9	4·55
2	1·3-1·6	1·5	2·2-3·0	2·6	3·3-4·1	3·7	3·65-4·5	4·1	3·9-4·7	4·3	4·15-4·85	4·5	4·25-4·9	4·6
Sample 8.														
31	1·55-2·5	2·01	3·2-4·2	3·66	—	—	—	—	—	—	—	—	3·8-5·0	4·27
131	1·0-2·5	1·61	2·15-3·9	3·03	3·3-4·7	4·01	—	—	—	—	—	—	3·6-5·2	4·3
59	1·0-2·3	1·66	2·35-3·9	3·12	3·15-4·6	3·98	3·5-5·2	4·42	—	—	—	—	3·75-5·4	4·66
19	1·45-2·05	1·61	2·35-3·75	2·98	3·6-4·4	3·97	4·05-4·8	4·41	4·3-5·1	4·64	—	—	4·4-5·2	4·78
5	1·3-2·3	1·61	2·4-3·9	3·02	3·6-4·5	3·98	4·0-4·9.	4·41	4·2-5·1	4·64	4·4-5·2	4·82	4·5-5·3	4·95

TABLE III.—Summary of Calculated Sizes in Cm. of Sample 7, 1914.

Winter Rings

Actual Size of Herrings.		1		2		3		4		5	
Range.	Mean.	Range	Mean.	Range.	Mean.	Range.	Mean.	Range.	Mean.	Range.	Mean.
19·6—21·4	20·5	13·5—15·8	14·6	—	—	—	—	—	—	—	—
20·3—24·2	22·0	6·6—14·0	10·0	15·3—22·3	18·3	—	—	—	—	—	—
21·8—26·2	23·4	4·6—12·0	8·2	11·2—19·9	15·8	19·0—23·7	21·3	—	—	—	—
23·6—26·7	25·3	6·8—11·6	9·3	14·3—20·9	17·2	19·0—24·2	22·0	22·3—26·0	24·3	—	—
24·9—25·6	25·3	8·2— 8·8	8·5	13·9—15·5	15·3	19·1—19·7	19·4	22·1—22·6	22·4	24·0—24·2	24·1

TABLE III.—Summary of Calculated Sizes in Cm. of Sample 8, 1914.

Winter Rings.

Actual Size of Herrings.		1		2		3		4		5	
Range	Mean.	Range	Mean.	Range.	Mean.	Range.	Mean.	Range.	Mean.	Range.	Mean.
22·8—25·0	23·9	9·3—12·7	11·3	17·8—22·8	20·3	—	—	—	—	—	—
21·8—27·9	24·5	5·9—13·7	9·0	13·0—20·5	16·9	19·8—26·0	22·2	—	—	—	—
23·1—27·9	25·7	5·4—12·6	9·4	13·6—21·4	17·3	20·1—24·7	22·0	21·7—26·7	24·5	—	—
24·8—27·5	26·0	7·1—11·0	9·0	13·5—19·8	16·3	19·5—23·3	21·5	22·3—25·6	23·9	24·0—26·9	25·3

At first sight it is natural to conclude that the contraction in size is due to an actual concentration of the structure of the scale, but it is at once evident from the above tables and from fig. 1, which has been constructed from the tables, that no such concentration takes place. The scales are not all of the same size in a given fish, but when sufficient numbers are examined and expressed either in terms of the length of the fish or in actual size it is plain that the scale expands proportionally to the length of the fish. In fig. 1 the growth of the scale has been plotted out with reference to the length of the fish and it has been found that the measurements resolve themselves into a straight line originating approximately in " o " as the various external measurements are found to do. The size of the scale from the centre as defined is about 0·0182 of the length of the herring.

The figure has been completed by the horizontal lines indicating the average size of the scale at the formation of each winter ring, and the points where these lines intersect the line of growth of the scale ought to express the average size of the herring at the formation of each winter ring.

If the facts thus indicate that the areas of summer growth delimited by each winter ring on the scale do not suffer contraction, the only other explanation which appears to be possible is that which has been advanced by Lea.* It is that the figures are accurately stated, that they express the average size at each successive year, that there is a progressive reduction in size due to selection. Many obvious facts could be adduced to support the contention.

It is evident from the figures submitted in the above tables that the herrings of one winter ring are large herrings of their group, and it is easy to understand that in drift net fishing the few examples caught would be large herring. The fish are not only large but their rapid growth is evidenced by the large size of the summer growth of the scale. Selection due to the mesh of the net takes place with reference to the younger age groups. The selection by the net cannot be said, however, to be the cause of the subsequent reduction in size amongst herring, all of which are equally liable to be caught by the drift net.

* 1913. Further Studies concerning the methods of calculating the Growth of the Herring. Publications de Circonstance, No. 66.

This Lea has made the attempt to explain by assuming that in a given year class the herrings are resolved into components according to the state of development, and that the change in the rate of growth is brought about by the herring forsaking one component and attaching themselves to another. In another place * I have tried to demonstrate that the products of each spawning ground are congregated into a shoal or shoals, and that they remain and grow and migrate together. It is evident that the large herring in each shoal will have opportunities of leaving to attach themselves to the group of the previous year, and similarly the smaller will be tempted to leave to join the group below. It is clear also that as the immature become mature they join in successive groups the spawning shoal until all the survivors at the end of this period have been absorbed. During this period the rate of growth gradually declines, but especially after the third year. As the same series of events follow one another every year it is difficult to follow Lea when he says that the immigration of the immature into the mature will cause a change in the growth dimensions. The feature of apparent contraction is equally well observed when immature herring are investigated as they are in the tables above.

Fortunately we are able to approach the subject in another way. The annual advent of the Northumberland school takes place each summer, and spawning occurs about the end of August. The first winter is therefore not recorded on the scales. The actual size of the herring ought to be then approximately that of the calculated size at each winter ring + 1 (w.r. + 1). We are thus able to contrast the actual with the calculated size.

The results of the examination in this manner are detailed in Table IV. The samples A—L are those already given in Table I., and samples 7 and 8 have also been considered (Tables II. and III.). The samples O—X are trawl caught herring of the season of 1913. The last are especially noteworthy for they are caught in September and October each year, at a period therefore close to that of the formation of the winter ring.

The above samples represent large enough numbers of herring to warrant general conclusions. Other analyses of a similar nature†

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* 1916. "The Migrations of Fish."

† One is given on page 76, "Migrations of Fish."

have been made, and there is no exception to the facts plainly exhibited in the table. The actual size is not very different from the calculated size. In some cases they are exactly in agreement. But it is plain that in every case the actual size at the first two winter rings is larger than the calculated size, at the third winter the sizes may be equal or somewhat greater or smaller, and at the fourth winter ring the calculated size is nearly always greater than the actual size. As will be seen there is no exception to the results thus stated in general terms. They are as constant as the apparent contraction in size revealed by calculation. There is no doubt either that the two results are causally related.

TABLE IV.—The Average Actual and the Calculated Sizes of Herrings.

Sample.	Size.	1	2	3	4
A—L ...	Actual ...	—	23·0	24·1	24·9
	w.r. + 1 ...	—	21·9	23·7	25·2
7	Actual ...	20·5	22·0	23·4	25·3
	w.r. + 1 ...	18·3	21·3	24·3	24·1
8	Actual ...	—	23·7	24·5	25·7
	w.r. + 1 ...	—	22·2	24·5	25·3
O	Actual ...	—	22·2	23·9	25·5
	w.r. + 1 ...	—	21·6	24·3	25·8
P	Actual ...	—	—	24·6	25·8
	w.r. + 1 ...	—	—	24·6	25·9
Q	Actual ...	—	21·9	23·1	25·0
	w.r. + 1 ...	—	20·8	23·8	25·2
R	Actual ...	—	23·1	25·0	25·8
	w.r. + 1 ...	—	23·0	24·7	26·3
S	Actual ...	—	22·9	24·1	26·0
	w.r. + 1 ...	—	21·8	24·0	26·2
T	Actual ...	—	23·7	24·5	25·8
	w.r. + 1 ...	—	22·3	24·6	26·1
U	Actual ...	—	22·0	23·4	25·3
	w.r. + 1	—	21·4	24·3	25·8
V	Actual ...	—	22·1	24·7	25·4
	w.r. + 1 ...	—	22·5	24·3	25·6
W	Actual ...	—	21·6	23·3	24·6
	w.r. + 1 ...	—	21·0	23·6	25·1
X	Actual ...	—	22·5	23·7	25·3
	w.r. + 1 ...	—	21·4	24·1	25·0
Average O—X ...	Actual ...	—	22·4	24·0	25·4
	w.r. + 1 ...	—	21·9	24·2	25·7

It is evident therefore that the scale does not grow exactly at the same rate as the fish. The scale is not formed until the herring has attained a size of about 4 cm. It appears late and

grows faster. The necessary correction has been indicated in fig. 1 by the dotted line. The two lines intersect at about the period of the formation of the fourth winter ring, and further work with reference to actual as compared with calculated growth may show that the point of coincidence is relatively constant with respect to size and age. The calculated size is too small previous to this point of coincidence and too large afterwards. It is easy to see that because of this want of correlation between the growth of the scale and the fish the first formed winter rings should present the descending series in size, but it is not so easy to point to any but an empirical method of correction.

From what has already been said, it is plain that selection takes place, but it is reassuring to find it is not an alarming selection with reference to size that a first view of the facts appeared to indicate.

The herring is the only species which has been intensively studied in this way. But probably the principle herein enunciated will be found to be generally true. In all cases we know the scale appears late, and the probability is that because of its late appearance it grows proportionally faster than the fish.

Lea refers to Sund's * paper on the sprat and Fage's † paper on the pilchard, in both of which it may be seen that the calculated size at each winter ring is smaller in successive year groups. From Sund's tables it is evident that in the sprat there is similarly a want of exact correlationship between the growth of the scale and the growth of the fish.

Size.	3	4	5	6
Actual	13·31	13·64	14·19	14·98
Calculated	12·88	13·99	14·72	15·32

Miss Lee ‡ has discussed the point also with regard to the herring, and found the conditions to be similar in the haddock. The feature is illustrated in this report in the paper by Mr. Storrow on the "Age and Growth of Fish," especially with reference to the long rough dab.

It is equally well illustrated in the many tables which have been published relating to the herring, and even if the younger calculated sizes be contrasted with the older calculated sizes.

* 1911. Undersökelser over Brislingen. Aarsberetning Vedkommende Norges Fiskerier.

† 1913. Recherches sur la biologie de la Sardine. Archives de Zoologie expérimentale et générale, tome 51.

‡ 1912. Publ. d. circ., No. 63.

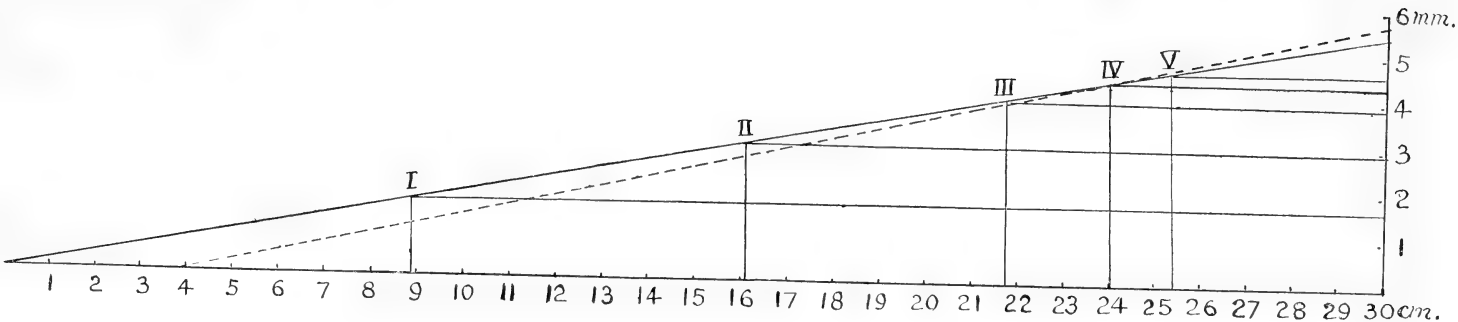


FIGURE I.—The growth of the scale in relation to the length of the herring—see explanation in text.

HERRING INVESTIGATIONS.

Size, Age and Maturity.

By B. STORROW.

Herring fishing during 1915 was somewhat restricted, but three samples have been examined. The samples were got from North Shields trawlers, but the locality of their capture and the age composition leave no doubt as to the shoal to which they belong. As in previous years ordinary commercial samples were obtained. It is interesting to note that during 1915 the herring caught on the trawled herring ground off the Yorkshire coast were not sorted, as a rule, before being put on the market, the small number of large fish making this process unnecessary. Sometimes the smallest herrings in the catch were sold separately.

The samples examined were as follows :—

Sample.	No. of Fish.	Date.	Where Captured.	Net.
1	300	12th Aug.	20 miles N.E. by N. of Tyne	Trawl
2	319	13th Sept....	65 miles E.S.E. of Tyne	Trawl
3	250	13th Oct. ...	70 miles E.S.E. of Tyne	Trawl

Size.—The length was measured, as in 1914, from the snout to the end of the upper lobe of the tail, which was moved so that its upper edge was parallel to the mid-line of the body. The fish have been grouped to the nearest centimetre, 20·6 to 21·5 cm. being counted as 21 cm.

The greater part of the sample of Northumberland coast herring, sample 1, consisted of fish from 23 to 25 cm. long, and the sample differed little in this respect from those of the same herrings examined in 1913 and 1914.

The herrings from the Yorkshire coast trawled herring ground, samples 2 and 3, were as in previous years larger than those from the Northumberland coast, but were smaller than the fish got from the same ground in other years, there being less than 14 per

cent. over 26 cm. in length, whereas in 1914 there was approximately 38 per cent. above this size, and in 1913 about 46 per cent. This decrease in the number of large fish caught is probably due to the heavy fishing to which the shoal has been subjected since 1911.

The variations in size will be seen from the particulars given below, and these may be compared with the tables given in the Reports, New Series, III. and IV.

CENTIMETRES.

Sample.		17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
1	Nos. ...	1	—	2	2	7	29	101	94	46	14	2	2	—	—	—
	% ...	0·3	—	0·7	0·7	2·3	9·7	33·7	31·3	15·3	4·7	0·7	0·7	—	—	—
2	Nos.	—	—	—	—	1	20	78	89	64	26	26	13	—	1	1
	% ...	—	—	—	—	0·3	6·3	24·5	27·9	20·1	8·1	8·1	4·1	—	0·3	0·3
3	Nos. ...	—	—	—	—	4	27	41	72	45	25	15	15	6	—	—
	% ...	—	—	—	—	1·6	10·8	16·4	28·8	18·0	10·0	6·0	6·0	2·4	—	—

AGE.—The predominant year group of the Northumberland coast herring, sample 1, was that with three winter rings.

The two samples of Yorkshire coast trawled herring also contained a large number of fish with three winter rings, but had more older herrings than the sample from the Northumberland coast.

The age composition of the samples was as follows ;—

WINTER RINGS.

Sample.		1	2	3	4	5	6	7	8	9	10	11
1	Nos. ...	1	50	201	37	8	1	—	—	—	—	1
	% ...	0·3	16·7	67·0	12·3	2·7	0·3	—	—	—	—	0·3
2	Nos. ...	—	65	154	64	8	23	1	1	2	1	—
	% ...	—	20·4	48·2	20·1	2·5	7·2	0·3	0·3	0·6	0·3	—
3	Nos.	2	35	114	56	8	29	—	1	3	1	—
	% ...	0·8	14·0	45·6	22·4	3·2	11·6	—	0·4	1·2	0·4	—

The number of fish with six winter rings in samples 2 and 3 is of interest as representing what remained in 1915 of the predominant year class in 1913, and which yielded in 1914 about 29 per cent. of the fish in the samples examined.

In 1913 and 1914, the age composition, in percentages, of Yorkshire coast trawled herring was as follows, and the average of the

two samples examined in 1915 is added for the purpose of comparison:—

Winter Rings.

	1	2	3	4	5	6	7	8	9	10	11	12	13
1913 Samples N, O, P, R, S, T	0·1	3·8	14·3	33·8	16·4	8·9	10·7	3·8	3·9	1·7	1·2	0·4	0·7
1914	1·0	8·5	24·8	16·0	28·8	10·5	4·0	2·3	1·3	1·0	0·3	0·3	0·8
1915	0·4	17·2	46·9	21·2	2·9	9·4	0·2	0·4	0·9	0·4	—	—	—

It will be seen from the above that the older fish are each year becoming less in number. In 1915 there was only 11 per cent. which had more than five winter rings, and in 1914 and 1913 the percentages were 20 and 31 respectively. This agrees with the decrease in size to which attention has already been drawn.

It would appear that the catches made from this shoal during 1916 should contain a fairly high percentage of herrings with four winter rings, but as the shoal is coming to be composed mainly of younger fish than in previous years the percentage of fish with four winter rings may be lessened somewhat by younger fish joining the shoal, and may not form the predominant year group.

Size and Age.—Table I. contains particulars relating to the size and age of the samples examined.

The average sizes of the different year groups, as calculated from the table, are as follows:—

Winter Rings.

Sample.	2	3	4	Month.
1	22·6	23·6	24·7	August.
2	23·2	23·9	25·5	September.
3	22·6	23·9	25·0	October.
2 and 3	23·0	23·9	25·2	—

The size of the fish with two winter rings and the age composition of the shoal leads one to the conclusion that whilst the more rapidly grown fish of the third summer may join the shoal of adult fish, the majority of the recruits of the adult shoal do not join the shoal until after the third winter ring has been formed.

Maturity.—Samples 1 and 2 were examined at North Shields in a curing house belonging to Mr. David Miller, and no data as to maturity were obtained. The various stages of maturity reached by the fish of sample 3 were as follows :—

Stages.	1	2	2—3	3	3—4	4	4—5	5	6	7	7—2	Total.
Males ...	8	9	—	17	7	20	10	29	—	21	1	122
Females	7	10	18	57	3	11	—	3	—	19	—	128

During August, September, and to the 9th of October, quantities of haddocks, gorged with herring eggs, were landed at North Shields from an area between the Longstone and the North East Bank, and bounded by 55° 32′, 55° 47′ N., and 0° 33′, 1° 24′ W. In some of the haddocks examined on 24th September, the herring eggs were well developed and not far from hatching. On the 4th and 5th of October, and from the same area, large full herrings were landed. They were larger in size than the ordinary catches landed at the port, and the roe and milt were running. It was impossible to obtain a sample of these, but a small number taken indiscriminately were measured, and varied in length from 28 to 31 cm. Mr. Richard Dawson, of Seahouses, has informed me that from the 21st to the 28th of August similar fish were landed at Seahouses.

The long period during which spawning herrings were off the northern part of the Northumberland coast is of interest, especially from its connexion with the herring fishing of previous years, when herrings were caught in Berwick Bay and Craster Smooth, as well as off the Longstone. In Craster Smooth herrings were caught in from 9 to 22 fathoms from Dunstanburgh—sometimes almost from Beadnell—to Boulmer.

At the time when these grounds were fished, it would appear from information obtained from fishermen and merchants along the coast that the chief fishing started at the beginning of August, or at the earliest towards the end of July, and was continued into September. The fish were ten inches or more long in August, and towards the end of the season from eight to nine inches. The August herrings, the largest of which were got from north-east

of the Longstone, were pickled. It is generally held that these herrings now rarely visit the coast, the last record of them previous to 1915 being some ten or twelve years ago. Towards the end of August spent fish became numerous, and the shoal departed to be replaced by a September shoal of smaller but full herrings. The fishermen at Beadnell are of the opinion that the herrings came to Craster Smooth from the north-east. After spawning, the fish moved quickly eastwards, and in such numbers as to occasionally take away the nets. The surface of the water when this movement was in progress was highly phosphorescent, and the path of the departing fish could be seen some time before they struck the nets.

Messrs. R. Boston & Sons, fish curers, of Spittal, have supplied the following interesting information regarding the herring shoals fished in former years.

" It was in the year 1901 that the last herring shoals visited Berwick Bay. The chief fishing was during the month of August, and more particularly towards the end of the month. The class of herrings caught were principally mat-fulls, and about ten inches in length. The greater part of them were salted and exported to the German and Russian markets. We always looked for the fish getting spent towards the end of the month, but after three or four days another school took their place, but did not stay so long on the ground, and generally disappeared about the first week in September. The shoals at the Longstone and Craster Smooth were fished at the same time, but a few days after they set in ' The Smooth,' they became softer and the women experienced difficulty in gutting them without tearing. These herrings were almost without exception mat-fulls. The herrings in Berwick Bay invariably set in at Burnmouth, and worked south to Holy Island Head. Berwick Bay was fished from two to five miles out."

The general opinion in connexion with the large shoals of adult spawning herrings, which used to visit the Northumberland coast, is that they came from the north-east, and that they did not reach this district until August, or at the earliest the latter part of July.

The fishing now carried on is mainly for young herrings, and at Seahouses, July is now considered the best month for herrings. It will be seen from the present paper and those in previous reports that the bulk of the fish since 1912 has consisted of herrings in their fourth summer, that is, with three winter rings on the scale, and that there has been no evidence of spawning to any extent since 1911. The fact is also illustrated by the absence of spawny haddocks from the region during these years.

In Report, New Series III., page 63, attention was drawn to the variations in the growth increments of fish with two, three and four winter rings in the samples obtained during 1913, and it was stated that these variations were taken as showing a change in the composition of the herring shoals off our coast, and that the change took place during the first and the beginning of the second week of September. It is difficult to make a definite statement, but there would appear to be some connexion between the change in the herring shoals here observed and the changes which took place in previous years when the August herring left after spawning, and was replaced by a smaller but full herring in the beginning of September.

There seems to be little doubt that intensity of fishing has been the cause of the changes in our local herring shoals, and it is highly probable that the period of rest which the shoals have enjoyed during 1915 may to some extent bring back the fisheries of Berwick Bay and Craster Smooth. Mr. Gray, of Craster, told me he had observed herring whales blowing in Craster Smooth several times in the middle of August last year, and the sight recalled to him the period when this was common, and herrings were caught there in large quantities.

No report has as yet been made as to the herrings examined during 1912. The samples were small and four in number, and the localities and method of capture were as follows :—

Sample.	No. of Fish.	Date.	Where Captured.	Net.
1	51	6th Sept. ...	60 miles E. by N. of Tyne ...	Drift.
2	59	10th Sept. ...	30 miles E. ½ N. of Tyne ...	Drift.
3	72	14th Oct. ...	130 miles E. ½ N. of Tyne ...	Trawl.
4	46	24th Oct. ...	Do. do. ...	Trawl.

The age composition of these samples was as follows :—

Winter Rings.

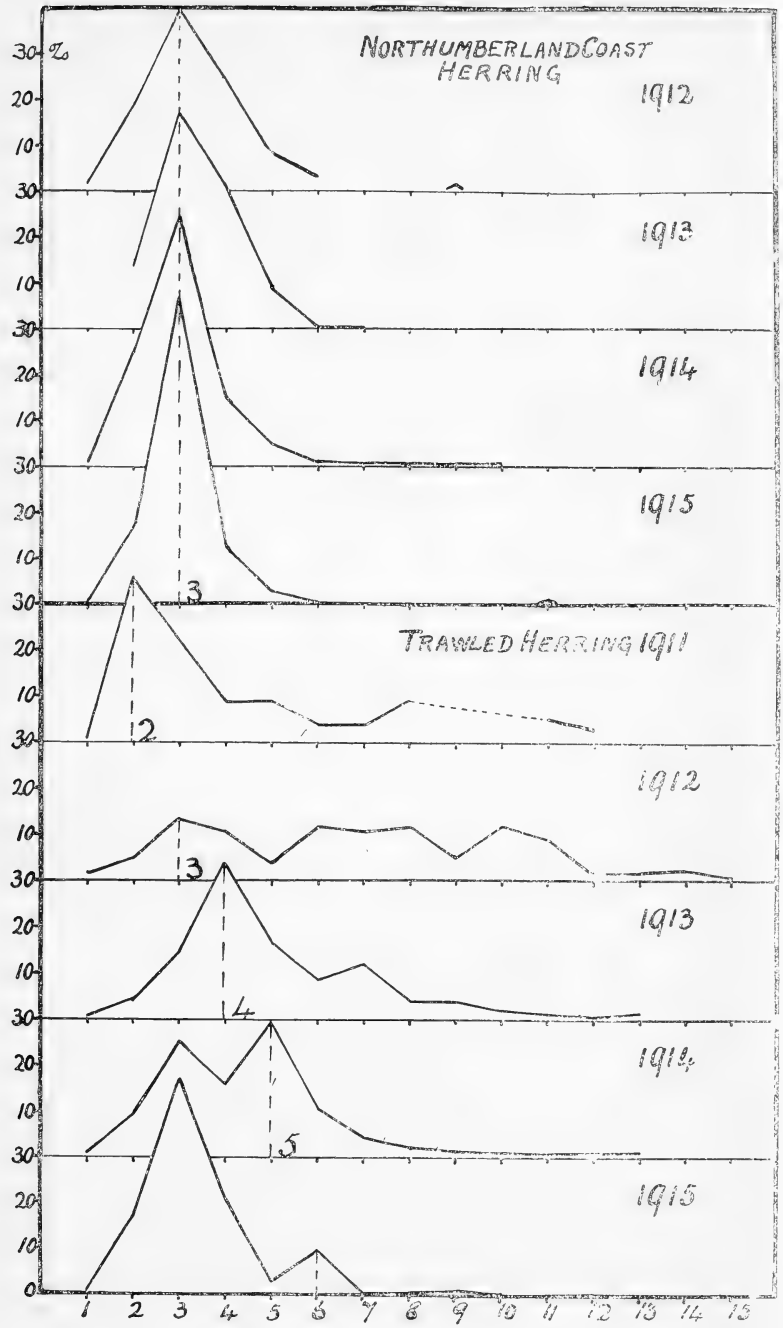
Samples.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Total.
1	—	4	14	16	7	5	1	3	—	—	—	—	—	—	—	50
2	1	11	24	15	5	2	—	—	1	—	—	—	—	—	—	59
2	2	6	9	8	4	10	8	10	5	4	5	—	1	—	—	72
4	—	—	6	5	1	4	5	4	1	10	6	2	1	—	1	46

The trawled herrings were sent to the Laboratory from Shields, and although it cannot be stated that the samples were true samples of the fish caught, it is significant that amongst the younger fish those with three winter rings were most plentiful, and these fish gave in the following year a high percentage of fish with four winter rings, and then formed the predominant year group.

TABLE I.—SIZE AND AGE.

CENTIMETRES.

Samples.	Winter Rings.	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	Total.
1	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1
	2	—	—	1	2	6	12	20	6	3	—	—	—	—	—	—	50
	3	—	—	1	—	1	17	77	72	29	3	1	—	—	—	—	201
	4	—	—	—	—	—	—	3	15	12	6	—	1	—	—	—	37
	5	—	—	—	—	—	—	—	1	1	5	1	—	—	—	—	8
	6	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	1
	11	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	1
		1	—	2	2	7	29	100	94	46	14	2	2	—	—	—	299
2	2	—	—	—	—	1	14	30	14	6	—	—	—	—	—	—	65
	3	—	—	—	—	—	6	46	67	32	3	—	—	—	—	—	154
	4	—	—	—	—	—	—	2	8	26	17	9	2	—	—	—	64
	5	—	—	—	—	—	—	—	—	—	4	4	—	—	—	—	8
	6	—	—	—	—	—	—	—	—	—	2	13	8	—	—	—	23
	7	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	1
	8	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	1
	9	—	—	—	—	—	—	—	—	—	—	—	1	—	1	—	2
	10	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	1
		—	—	—	—	1	20	78	89	64	26	26	13	—	1	1	319
3	1	—	—	—	—	2	—	—	—	—	—	—	—	—	—	—	2
	2	—	—	—	—	2	17	10	6	—	—	—	—	—	—	—	35
	3	—	—	—	—	—	10	28	49	23	4	—	—	—	—	—	114
	4	—	—	—	—	—	—	3	17	21	10	4	1	—	—	—	56
	5	—	—	—	—	—	—	—	—	—	5	2	1	—	—	—	8
	6	—	—	—	—	—	—	—	—	—	6	9	11	3	—	—	29
	8	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	1
	9	—	—	—	—	—	—	—	—	—	—	—	—	3	—	—	3
	10	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	1
		—	—	—	—	4	27	41	72	44	25	15	15	6	—	—	249



HERRING INVESTIGATIONS—AGE COMPOSITION.

LOBSTER CULTURE.

By B. STORROW.

The object of the experiments in lobster culture conducted during the summer of 1915 was to ascertain if possible a suitable food for young lobsters during the larval stages.

The berried females necessary for the experiment were obtained from local fishermen, and early in May seven were placed in each of the large supply tanks outside the building. The number of larvae obtained was not so great as in previous years, due, no doubt, to the lobsters being caught and kept in captivity some two months before hatching took place. This was necessary, as at this period most of the fishermen were taking out their lobster pots and preparing for the salmon fishing. A large berried female, obtained towards the end of June, and having the eggs nearly ready for hatching, was placed in one of the large tanks of the Aquarium, and gave a good supply of larvae.

The tanks used were completely isolated by screens of mosquito netting, and were of three sizes, the space available for the larvae being as follows :—

A. $39 \times 29 \times 10\frac{3}{4}$ cubic inches.
B. $32 \times 22 \times 8\frac{3}{4}$,,
C. $33 \times 17 \times 8\frac{3}{4}$,,

In the first six experiments tanks of the A and B size were used, and obtained an abundant supply of water by means of connexions made by rubber and glass tubing to the ordinary taps of the Aquarium. Fine nozzles were made from glass tubing, and together with pieces of glass tubing long enough to reach to the bottom of the tank, were lashed to short pieces of wood in such a manner as to allow of the jet of water from the nozzle carrying with it down the tube the maximum quantity of air. By this means not only was an adequate supply of water obtained but also an efficient aeration of the tank, and by inclining the glass tubes it was possible to produce a current which circulated round the tank, and tended to keep the larvae from settling on the bottom.

But the tanks being rectangular it was found that the larvae drifted out of the current and settled in the corners, and further the current was not strong enough to keep the larvae from the bottom of the tank when they showed a tendency to remain there. It was, as a rule, some five or six days after hatching before any number of the larvae was observed on the bottom, and after that the number varied somewhat, being greatest at the periods of moulting.

To some extent this settling of the larvae, which allowed of the less active being attacked by the more vigorous and stronger swimmers, was prevented by stirring the water frequently during the day with a wooden paddle. This not only moved the larvae but also any food which had fallen to the bottom of the tank.

The constant supply of water to the tanks brought a quantity of mud and fine sand, the amount varying according to the condition of the sea. When the sea was other than calm it was impossible to allow time for the water to remain long enough in the supply tanks to settle, and it was found that the bottom of the rearing tanks became covered with fine sediment which had to be removed, periodically. Experiments 7 to 11, in which the water was aerated by air driven through pieces of rubber tubing punctured by a needle, were therefore conducted, and the water supply was regulated to allow of only clear water being used. Two tubes connected, with the air supply, were led into each tank, and the pieces of punctured rubber tubing, about three inches in length, were kept down by means of small stones. When suitably arranged these gave a current, but it was weak and of little or no value, and here, as before, the water was frequently moved by a wooden paddle.

The foods used were such as could be most easily obtained in quantity, and consisted of shore crab (*Carcinus maenas*), mussel and fish (whiting). Later, fish liver and ox liver were tried. The food was put through a mincer and then aerated by driving water from a fine nozzle through a piece of tubing into the dish containing the food By this method it was possible to cause the greater part of the food, except in the case of ox liver, to float or be suspended in the water for some hours. Food was given daily, after first removing the surplus from the previous day. All the foods used were taken by the larvæ and carried about by them until apparently sufficient had been eaten.

Table I. gives particulars of the experiments.

TABLE I.

Experiment.	Tank.	No. of Tanks.	Commenced.	Larvae per Tank.	Total Larvae.	Ended.	Total Larvae.		Food.
							3rd.	2nd.	
1	A	2	22nd June	50	100	13th July	6	3	Shore crab, mussel, whiting.
2	A	4	23rd June	100	400	13th July	18	11	Do. do.
3	A	3	25th June	100	300	13th July	2	8	Whiting.
4	A	1	30th June	100	100	13th July	—	6	Do.
5	B	4	30th June	100	400	19th July	56	19	Shore crab.
6	B	4	2nd July	100	400	19th July	9	27	Mussel.
*7	C	6	14th July	100	600	4th Aug.	29	—	Shore crab, mussel, whiting.
8	A	3	16th July	200	600	5th Aug.	33	5	Shore crab, mussel, whiting, fish liver.
9	A	3	16th July	150	450	5th Aug.	58	20	Shore crab, mussel, whiting, ox liver.
10	B	3	22nd July	100	300	5th Aug.	2	19	Ox liver.
11	B	2	23rd July	100	200	5th Aug.	—	12	Fish liver.

* Experiments 7 to 11.—Water ærated by driving air through a piece of punctured rubber tubing, and water supply cut down, one tap supplying three tanks.

In experiment 5, in two of the tanks, a small quantity of seaweed, chiefly Ulva, came through the pipes when the taps were being cleaned. This was allowed to remain in the tanks, and it was noticed that some of the larvae got under the weed, with the result that they were not so liable to attack from the others when they were moulting. On examination these two tanks contained more larvae than did the other two of the same experiment. Seaweed was therefore used in experiments 7 to 11, and without doubt, by affording shelter, tended to lessen the death rate.

It will be observed from the table that the larvae were kept under observation for periods of about three weeks in each experiment, with the exception of experiments 10 and 11. The chief object was to compare the effect of different foods under the same conditions, and space and time did not allow of the experiments being prolonged. In the case of the two last experiments the food was obviously unsuitable.

So far as these experiments go they point to a crustacean diet being most suitable for the larval lobsters, experiments 5 and 9. Mussels are next in value, but are inferior to shore crabs, and fish is practically of no value. Ox liver does not seem to be of much use, but is evidently less harmful than fish liver, which appears to have a most detrimental effect, experiments 8, 9, 10 and 11. There is no doubt that fish liver was eaten, since after the larvae had been fed for two or three days the food contained in the stomach made the colour of the larvae, in the thoracic region, considerably lighter.

The larvae after being counted were put to sea.

That the water in the rearing tanks should be constantly in motion was emphasised from observations made during the experiments, and it is becoming more and more evident that no great success will be obtained in the rearing of larval lobsters until, as suggested by Professor Meek in this Report, New Series, III., page 81, some modification of the floating tank system, suitable to the locality, is used.

THE BAIT RESOURCES OF THE DISTRICT.

By B. STORROW.

Travelling along the Northumberland coast from Berwick to the Tyne one is struck with the fact that wherever on this open coast the nature of the rocks and the line of the shore provide any protection for small boats there a fishing station has been established. There are fourteen of these stations, some being quite small villages, such as Beadnell, Newton and Cresswell, whilst others, such as Berwick, Amble and Blyth, are associated with towns, the main population of which is engaged in different industries.

During the year 1914 the total value of the white fish landed at these fourteen stations was over £10,000, and in 1915 it exceeded £20,000. Fishing is carried on in inshore waters by means of lines chiefly in the winter months, from October to March, and during this period about 80 per cent. of the total white fish is caught. In spring, crab and lobster fishing is commenced, and at various stations salmon fishing is pursued.

The chief bait for line fishing consists of mussels. Only one of the stations has an adequate supply of mussels for bait within easy reach, and the greater part of the mussels used on the coast is brought by rail from Morecambe Bay and the region of the Wash. Many of the fishermen therefore make a practice of baiting alternate hooks with limpets, and occasionally the whole line has to be thus baited. A worm bait, consisting chiefly of lugworm, *Arenicola marina*, is used in spring, when mussels are becoming unsuitable for bait, and also during the summer months. Other baits which are occasionally used are anemones obtained from the rocks, chiefly in spring, and looked upon at Newbiggin as most effective. "Hairy worms," under which heading are included *Nereis virens*, *Nephthys caeca* and *N. hombergii*, are considered excellent bait, and are used whenever obtained, but chiefly during the spring. At some of the stations, such as Berwick, Craster and Newbiggin, herrings are purchased from the herring boats by the inshore fishermen from May to August. Shore crabs

are occasionally used for catching codling, and hermit crabs caught when fishing for edible crabs and lobsters are also used. Thirty years ago, at Berwick, pots were baited to catch shore crabs. Sand-eels, when easily obtained, are used during the summer, but this bait is not sought after to anything like the same extent as in former years. Occasionally a rough sea washes ashore "clams," Solen and Mya, and at Alnmouth these are used. Ox liver was used and considered a good bait for haddocks some thirty years ago, at which time sprats were also used for the same purpose. During last winter sprats bought at North Shields fish quay were used by the Cullercoats fishermen for catching haddocks. At some of the northern stations the "ripper" or "jigger," a piece of bright lead to which hooks are attached and jerked up and down in the water, is used for catching cod.

Railway facilities have made it possible to obtain mussels in quantity, and therefore the tendency is to use more and more mussels and neglect baits which cannot be obtained without considerable labour and expenditure of time.

The fishing stations and the different kinds of bait there available will now be considered.

Berwick.—Mussels are obtained in the Tweed from below the bridge to the piers. They are got between tide marks near low water, and may also be taken by dredging. The supply is not sufficient for the ten to sixteen boats which land their catches at this station, and use weekly during the season about two bags of mussels per man. Mussels are therefore obtained from Morecambe Bay, and occasionally in small quantities from Newhaven, on the Firth of Forth. Behind the north pier a patch of sand, sheltered somewhat by rocks from the full force of the sea, yields a good supply of Arenicola. The rocks to the north and south of the mouth of the Tweed provide sufficient limpets of good size to meet all the requirements of the fishermen now, but this was not the case when some fifty or sixty boats fished from Berwick and Spittal, and the Burnmouth fishermen came south for limpets. Formerly, Pholas, obtained by breaking up the Carboniferous shales on the coast, was used as bait.

Holy Island.—No fishing station could have better bait resources than here exist. Fenham Flats provide a large area

for the settling of mussel spat, which grows, although slowly, to a size big enough for bait purposes. Mussels of larger size are to be found on the Oyster Scaup, the best area in this district for the rapid growth of mussels. During the winter 1914-15 almost the whole of the mussels used for bait were obtained from a salt water channel called the Burn, which runs round the Snook, by the Lifeboat House, into the sea. The mussels here are of good size, and some got from the centre of the channel were three inches in length. Here also are quantities of young mussels along the landward side of the channel, but these being nearer high water mark are slower of growth and would be improved by being transplanted and put into or nearer the channel as it exists at low water. In the Hen Pool and at Black Law Point are quantities of young mussels which only need transplanting to the Oyster Scaup to become of a good size for bait. This is done by some of the fishermen, but the majority are content with the mussels found on Fenham Flats or in the vicinity of the Snook.

From St. Cuthbert's Island to the Snook, from the edge of the Burn almost to high water mark, Arenicola is to be found in very large quantities. It is also plentiful in the Ooze and the small bay near the Castle, and some are to be obtained between the Snook and the Lifeboat House at the western corner of the island. From the Snook to Emmanuel Head few lugworms are to be found, but elsewhere there is an abundance, and far more than is required.

Nereis virens, locally known as "Hairy Mary," is got at low water from the muddy sand overlying rocks in the bay near the Castle, and also from the eastern part of the Ooze.

Limpets are common on the rocks between the Castle and Emmanuel Head, and also between the latter point and the Snook. They are not used as a rule for bait, except in January and February, and then only in small numbers.

As a fishing station Holy Island suffers from a lack of facilities for the marketing of the fish caught. Everything has to be carted to the mainland, and this considerably lessens the value of the catch.

Seahouses.—The mussel beds at Budle, see Report, 1906 pp. 33-36, are now of little value. They were until recently rented by Mr. Richard Dawson, of Seahouses, but since his giving up of the lease they have been spoilt by over-fishing, and now although mussels of good size are to be found in and near the channels formed by the Waren they are far from being plentiful. There are numbers of young mussels on the northern portion of Warnham Flats, but these to be of any use for bait should be transplanted into the channels near the Oyster Pond. Most of the mussels now used at Seahouses come from Morecambe Bay.

Arenicola is common along the water channels to the south of Warnham Flats, and is also got from the sand to the south of Seahouses harbour, and the sandy bays between Seahouses and Beadnell.

Nereis virens, here called the "Ragworm," is found in the Oyster Pond at Budle, and also in Seahouses harbour in muddy sand above rock. The supply is limited, and it is difficult to get in any quantity. It is used in winter.

There is a good supply of limpets on the local rocks, and also on the Farne Islands.

Beadnell.—The mussels used at Beadnell come from Morecambe. Inside the harbour and in the sand to the north thereof Arenicola is common, but is not found in any number to the south of the harbour. This bait is here used chiefly in spring and summer for flat fish. Limpets are plentiful, and when used for haddock fishing are put on the hooks after a mussel in order to prevent the easy removal of the mussel. A small number of *Nereis virens* is found at Beadnell Point, and Nephthys is turned up when digging for Arenicola. Anemones from the rocks in the vicinity are sometimes used as bait in spring.

Newton.—Arenicola is abundant in the harbour, and limpets and anemones are to be found on the rocks.

Craster.—This station has the worst supply of bait in the district. All the mussels used have to be brought from a distance, chiefly from Morecambe. Arenicola occurs in very small numbers

in the harbour, and it would be difficult to obtain sufficient to bait a line. The limpets to be found on the basalt rocks of the neighbourhood are small in numbers and poor in size.

Boulmer.—Arenicola is plentiful in the harbour, and in sandy patches to the south of the village. Occasionally Nephthys is found, and is here called the "Ragworm." There is a good supply of limpets, but no mussels.

Alnmouth.—On the south bank of the Aln, at its mouth, are beds of small mussels, the majority of which are less than an inch long, and are stunted in growth. They are unsuitable for bait purposes, and there does not appear to be any place to which they could be transplanted. The supply of Arenicola is poor, and has to be obtained from Boulmer. Nephthys was found amongst the muddy sand at the south of the mouth of the Aln, but in small numbers. Anemones are used as bait at this station, but are scarce.

Amble.—Mussels are to be found at the mouth of the Coquet in sufficient quantity to supply this station, and to some extent also Hauxley. Most are got from the south side of Warkworth Harbour, but a fair number of large mussels are now to be found on the north side. Arenicola exists in the same localities, but those at the south of the harbour are deep and hard to find. Limpets are got from the rocks between Amble and Hauxley.

Hauxley.—Mussels are obtained from Amble, and some from Morecambe Bay. For the last two years few Arenicola have been found, owing to heavy seas having moved the sand in the harbour, and now only small numbers occur in sandy patches between the rocks near low water mark. Limpets are plentiful on the local rocks. There are few anemones.

Cresswell.—The Cresswell fishermen also, but to a less extent than those of Hauxley, have had their Arenicola beds spoilt by moving sand. Limpets are insufficient in quantity, and mussels are got from Boston and Morecambe.

Newbiggin.—The only local mussels used here are small quantities obtained from Blyth during the summer. Arenicola in fair quantity is obtained, and the number of limpets gathered from the local rocks does not meet the demand.

Blyth.—Owing to the quantities taken by Newbiggin and Cullercoats fishermen, and the taking of mussels for other than bait purposes, the mussel beds of the Blyth are now almost exhausted. Arenicola is found in patches of muddy sand above the harbour, and in a small area to the south of Cambois Bay. The rocks to the north of the entrance of the harbour yield a good supply of limpets and some anemones.

Cullercoats.—Practically no mussels are now got from the Black Middens at the mouth of the Tyne, and all come from Morecambe Bay or the Wash. Arenicola is plentiful in Cullercoats harbour, at the Black Middens, and in patches of sand to the north of Whitley Bay. Limpets are very plentiful, but are rarely used as a bait unless the mussel supply fails or in spring. Anemones are common, but seldom used. *Nereis virens* is found in the muddy sand near the Black Middens, and is used whenever obtained. Nephthys is not used as a bait, but occurs in the locality, and the same applies to *Nereis pelagica* and *N. cultrifera*.

It is evident that the chief bait used by the fishermen of Northumberland consists of mussels, and that large quantities are brought into the district from outside. It will be of interest therefore to see what is the value of the imported mussels, and if it is possible for the district to supply its own fishermen.

During the year 1915 there were some ninety boats and 312 men engaged in inshore line fishing, and the average number of boats for other years is approximately 100. Each man, on an average, has twelve pieces of line on which are 1,200 hooks, and a bag of mussels will bait the lines for one man twice, or if limpets are used in addition to the mussels four times. If four days fishing per week be taken as an average throughout the season, October to March, to allow for bad weather stopping the fishing, and the stations which have their own mussel supply, as Holy Island and Amble, be neglected, and allowance be made for the

use of limpets with mussels, there are some 390 bags of mussels per week brought from outside sources to the fishing stations of Northumberland. For the six months period this gives a total of over 10,000 bags of mussels. The fishermen pay at the rate of 2s. per bag for the gathering of the mussels, and in addition to this there is railway carriage, which varies from 2s. to 2s. 6d. per bag. The fishermen of the district are paying therefore a yearly sum of £2,000 for mussels.

That mussels can be grown suitable for bait purposes in the region of Holy Island, and also that Fenham Flats yield an abundance of young mussels for transplantation, has been shown in previous reports. The area suitable for the cultivation of mussels is here large and could be made to supply the present requirements of our fishermen, and there is at Budle another area which could also be utilised for the purpose.

Given the required capital to start the cultivation of mussels there appears to be little doubt that, with proper management, the industry could be made self-supporting, thus providing employment for a number of men as well as keeping a large sum of money circulating in our own district.

NOTES ON THE AGE AND GROWTH OF FISH.

By B. STORROW.

LEMON DAB, *Pleuronectes microcephalus.*

On 1st April, 1916, eight lemon dabs, or rather what was left after the flesh had been removed by filleting, were examined to ascertain if it was possible to tell the age from the otoliths. The otoliths were found to be small, and whilst the growth areas were marked they were far from being as clear and as easily read as in the plaice and common dab. As there was a small portion of skin left above the pectoral fin some scales were examined, and as will be seen from the photographs on Plate I., the growth areas are most distinct. Fig. 1 is a scale from a fish 23·8 cm. long, caught 17th April, and shows three summer areas of growth, and the beginning of the fourth. Fig. 2 from a fish 41·5 cm. long shows nine summer areas ; the demarcation between the eighth and ninth summer is somewhat indistinct in the photograph, but was easily seen under the microscope.

It will be seen from the photographs that the growth of the scale is rapid at the beginning of the summer, and then gradually slows down until the concentric ridges come very close together. When the scale is examined under a high power there are seen at the sides of the radiating grooves faint lines which connect the concentric ridges here broken by the radiating grooves. These faint lines are interrupted at the end of each year's growth, and are of great help when determining the age of old fish.

Before proceeding with further work in this direction it was essential to see if scales from other parts of the body gave the same result as those from the region above the pectoral fin. For this purpose two lemon dabs were obtained, and 140 scales were examined from each fish. Scales were taken from seven areas on the right side of the body. The areas selected were situated above and below the lateral line, and were one-third of the length,

half the length, and two-thirds of the length behind the head. The seventh area was above the pectoral fin, and in the same position as the piece of skin left after the fish had been filleted. All the scales, except those on which the concentric ridges were absent about the focus of the scale, gave the same reading for age. The fish were 35·8 and 36·5 cms. long, and had on the scales six and seven summer areas respectively.

The Laboratory attendant obtained for me on 4th April the remains after filleting of fifty-six lemon dabs which were caught 130 miles N.E. of the Tyne, and on 10th April measurements and scale samples were taken at North Shields fish quay from thirty-six fish caught 170 miles N.E. of the Tyne.

The length of the fish was measured to the nearest half centimetre, and the average size and range in size of the fish examined were as follows :—

Age.	4	5	6	7	8	9	10	11	12	13	14	16	
Average size	26·9	31·6	33·7	34·9	36·7	39·2	38·9	41·0	39·8	41·7	40·9	42·0	cm.

Age.	4	5	6	7	8	
Range ...	25·0—31·0	25·0—39·0	27·5—39·5	30·0—38·5	34·0—40·5	cm.

Further particulars will be found in Table I.

It will be seen that no fish younger than four years was examined, and in order to obtain some idea of the growth in earlier years a linear representation of the scale was made, and the size and growth of the scale was expressed in terms of the length of the fish in the same manner as has been done in herring investigations. The limits of each year's growth of the scale are easily determined, and as the results obtained, for fish having completed from four to seven years' growth, agree very closely with the figures given above, it will probably be found, from an investigation of younger fish, when these can be obtained, that a fair representation of the growth of the lemon dab is here given.

Particulars as to the calculations made will be found in Table II., and the average size and range in size at the end of each year's

growth, as obtained by expressing the scales in terms of the length of the fish, were as follows :—

Average Size at end of Year's Growth.

Age.	No. Examined.	1	2	3	4	5	6	7
4	4	7·4	13·7	21·7	26·4	—	—	—
5	22	7·4	14·5	21·2	27·1	32·3	—	—
6	14	7·2	13·4	20·4	26·1	30·4	—	—
7	9	6·9	13·4	19·6	24·7	29·1	32·1	—
8	4	7·5	15·4	24·2	28·9	32·0	33·8	35·2
9	3	7·1	15·0	22·0	27·8	31·3	34·1	36·3
10	4	7·5	15·0	21·9	27·3	30·6	33·9	34·4
Average	... ...	7·3	14·3	21·6	26·9	31·0	33·5	35·3

Age.	1	2	3	4	5	6	7
Range ...	4·3-11·4	9·8-20·4	15·4-30·2	20·4-35·6	24·5-38·8	28·2-38·4	31·8-39·0

The fish were landed, as has already been stated, between the 4th and 10th of April, and growth for this year had commenced in most of the fish of four and five years of age, but in only a small number of older fish could there be seen anything to show that growth had begun. Two small lemon dabs, 23·8 and 18·6 cm. long, obtained from samples of plaice and common dabs from Blyth Bay, were got on the 17th and 20th of April respectively. They had completed three years' growth, and the fourth, as will be seen from fig. 1, Plate I., was represented by some four or five concentric ridges at the anterior portion of the scale.

It is apparent therefore that in the case of young lemon dabs growth begins in March. Fish which are from five to six years of age, and in which growth is slowing down, do not commence their year's growth until the end of March or the beginning of April, and this is further postponed in the case of older fish.

DAB AND PLAICE *Pleuronectes limanda* and *P. platessa.*

Every year during April and May quantities of small flat fish, consisting chiefly of young dabs and plaice and a small number

of long rough dabs and flounders, are landed at North Shields. Most of them are caught just outside the three-mile limit.

Three samples of these were obtained, and by means of the otoliths the age of the dabs and plaice has been determined. The otolith of the dab shows the age very clearly as a rule, but cases have been met in which the otoliths were difficult to read, and appeal has had to be made to the scales before the age could be definitely stated. It is interesting to note that the otoliths from both the plaice and the dabs showed in all cases that the summer's growth for the year had begun.

The age composition of the samples examined, as well as the average size and range in size, in centimetres, for each year group are given below, and further particulars will be found in Tables III. and IV., for the making of which the three samples have been considered as one.

As the first sample was selected with the object of making an examination of the smallest fish landed, the average size of the three-year old dabs is low. The other two samples were taken without selection.

Dabs.—14th April, 1916, 5 miles E.S.E. of Coquet Island, 27 fathoms.

Age	2	3	4	5
No. of Fish ...	34	22	13	3
Average Size ...	13·7	15·9	22·6	26·7
Range	10·6—16·2	13·2—20·5	18·0—27·5	26·3—27·4

17th April, 1916, Blyth Bay, 28-30 fathoms.

Age.	2	3	4	5
No. of Fish ...	44	63	20	2
Average Size ...	13·6	17·8	21·7	23·8
Range	10·1—17·0	13·2—25·5	18·5—26·2	21·5—26·0

20th April, 1916, Blyth and Cambois Bays, 28-30 fathoms.

Age.	2	3	4	5
No. of Fish ...	48	101	19	—
Average Size ...	14·1	18·2	21·5	—
Range	10·5—18·9	13·5—23·8	17·9—25·8	—

All samples.

Age.	2	3	4	5
No. of Fish ...	126	186	52	5
Average Size ...	13·8	17·8	21·9	25·5
Range	10·1—18·9	13·2—25·5	17·9—27·5	21·5—27·4

Plaice.—As the number of plaice was small in each of the samples the totals only are here given.

Age.	2	3	4	5
No. of Fish ...	31	53	9	2
Average Size ...	14·9	19·0	23·2	24·5
Range	11·5—19·2	13·5—25·6	20·6—26·0	23·2—25·8

Not one fish of the age of one year was found in the samples. It is difficult to imagine that if these were present on the ground fished all would have been able to escape through the mesh of the trawl, and it is more than probable that these young fish occur in shallower water nearer the coast.

In August of 1915 some young plaice, together with a small number of young turbot were caught on Cullercoats sands with a small shrimp net. A number of these were put into a tank, and kept under observation with the object of obtaining some information as to the rate of growth. All the young fish were in one tank under the same conditions, which have been constant, and the food supply, which has consisted of mussels, lugworms, and occasionally limpets, has always been more than sufficient.

There is therefore no question as to the smallest of the young fish not being able to obtain the amount of food required. The fish were measured periodically, and the dates and results of the measurements made will be found in Table V.

There are three points which are apparent from the measurements of the young plaice. The first is that growth was not stopped during the winter: secondly, the rate of growth, for the time they have been under observation, has not been regular; and thirdly, during the month of January growth was more rapid than in either December or February.

The average sizes of the young plaice at each time of measurement and also the average growth increments are here given.

Date	24th Aug.	4th Oct.	1st Nov.	2nd Dec.	5th Jan.	1st Feb.	7th Mar.	7th Apr.	19th May.	19th June.
Average size	4·0	4·7	5·7	6·3	6·6	7·3	7·7	8·2	8·8	9·6 cm.
Average Increment	0·7	1·0	0·6	0·3	0·7	0·4	0·5	0·6	0·8	cm.

During December the young plaice made attempts to leave the tank, and seven of them escaped by means of the overflow into the next tank. They were returned.

There are only three turbot now living out of the five put into the tank, but these differ from the young plaice in that during December, January and February no increase in length was made.

HALIBUT, *Hippoglossus vulgaris.*

Owing to the kindness of several people at North Shields fish quay, and chiefly to that of Mrs. J. A. Taylor and Mr. T. Dunn, it has been possible to obtain measurements and otoliths from forty-eight halibut.

The age of the halibut is shown on the otoliths, which are built up of areas or zones alternately opaque and more or less transparent when viewed by transmitted light, and alternately white and dark when viewed by reflected light. Fig. 1, Plate II., is a photograph by reflected light of the otolith of a halibut, 61 cm. long, landed at North Shields, 10th April, 1916. Very faint

indications that growth of the present summer zone was beginning were to be seen on most of the otoliths examined.

The scales in some cases are useful to check the reading obtained from the otoliths, but as a rule they are difficult to read. From the number examined it would appear that it is only in the case of fish small for their age that the winter areas on the scales are strongly marked and easily read. The scales of one fish, 52 cm. long, and landed 18th March, had six winter areas most distinct, but this fish was small and appeared old for its size, and it was on this account that the fish was given me for examination.

The date of landing and the size and age of the halibut examined were as follows :—

Date.	Size.	Age.	Date.	Size.	Age.
	cm.			cm.	
30th March... ...	30·0	2	8th June	98·0	5
30th March... ...	30·5	2	18th March... ...	52·0	6
25th April	34·5*	2	19th April	75·0	6
1st April	44·5	3	20th April	82·0	6
25th April	42·0*	4	19th April	78·5	7
20th April	43·5*	4	20th April	95·5	7
25th April	45·0*	4	17th April	86·5	8
10th April	59·5	4	17th April	87·5	8
10th April	52·5	5	1st April	95·5	8
7th April	60·5	5	20th April	97·0	8
3rd June	60·5	5	20th June	101·0	8
10th April	61·0	5	1st June	102·0	8
10th April	66·5	5	25th May	103·5	8
19th April	72·0	5	18th May	113·5	8
30th May	72·5	5	10th April	93·0	9
10th April	73·0	5	10th April	98·0	9
3rd June	75·0	5	10th April	101·5	9
30th May	77·5	5	25th May	109·5	9
8th June	81·0	5	12th June	111·5	9
6th April	83·0	5	27th March... ...	98·5	10
29th March... ...	86·0	5	20th April	103·5	10
12th June	87·0	5	19th June	112·5	10
10th April	90·0	5	3rd April	116·0	10
24th May	96·5	5	10th April	120·0	12

* Found in boxes of plaice from Norway.

LONG ROUGH DAB, *Hippoglossoides limandoides.*

The fish examined were found amongst a sample of small dabs and plaice caught in Blyth Bay, 28 to 30 fathoms, 17th April, 1916.

For the purpose of age determination the scales of the long rough dab are very similar to those of the lemon dab. The concentric ridges are wide apart in that portion of the scale formed during the summer, and approach closer to one another in the slower growing period of winter. The otoliths also are clearly marked with zones of growth, and have been used to check the results obtained from the scales.

The age composition and the average size and range in size in cm. of the fish examined were as follows :—

Age.	2	3	4	5	6
No. of Fish	24	26	28	12	1
Average Size	15·6	17·6	19·0	19·6	20·8
Range	14·2—16·8	15·8—19·8	17·3—20·4	18·6—21·2	—

An attempt has been made to calculate the growth of the long rough dab from the scales. Although the end of each year's growth is not so clearly marked as in the scale of the lemon dab it can be fixed with a fair amount of accuracy, especially if when examined under the projection microscope the scale is thrown slightly out of focus.

A summary of the calculations made is here given :—

Average Size at end of Year's Growth.

Age.	No. Examined.	1	2	3	4	5	6
2	24	6·7	15·3	—	—	—	—
3	26	6·5	13·2	17·6	—	—	—
4	28	5·8	12·3	16·2	19·0	—	—
5	12	5·7	11·5	15·6	17.9	19·6	—
6	1	5·0	10·5	14·4	17·3	19·6	20·8

The range in size as obtained from the calculations was as follows :—

Age.	No. Examined.	Range at end of Year's Growth. 1	2	3	4	5
2	24	5·5—7·9	13·8—16·4	—	—	—
3	26	5·0—7·9	11·7—15·8	15·2—19·8	—	—
4	28	4·3—7·0	10·4—13·8	14·4—18·8	18·6—21·2	—
5	12	3·3—7·6	8·5—13·4	14·6—16·7	17·3—19·0	18·6—21·2

The average size and the range in size, as calculated from the scales, at the end of each year's growth vary according to age, and remind one of the results obtained from the scales of the herring.

The present year's growth had commenced in nearly all fish of two years of age, and in one or two of those a year older, but it had not done so in any of the older fish.

The sample consisted of 91 fish, and of these four only were males. The condition of the gonads was as follows :—

Age.	Immature.	Ripe.	Spent.
2	24	—	—
3	9	1	16
4	2	1	25
5	—	1	11
6	—	—	1

BALLAN WRASSE, *Labrus bergylta.*

A young ballan wrasse from two to three centimetres in length, was caught in a rock pool at Cullercoats, and placed in one of the

Aquarium tanks in August, 1914. On 17th January, 1916, the young fish measured eight centimetres, and had then completed two summers' growths. Fig. 2, Plate II., is a photograph of part of a scale taken from the fish at this date. It is evident that the first winter is marked on the scale, and from a consideration of the direction of the concentric ridges, especially in the lateral portions of the scale, it is also evident that the marking of the winter is due to a complete stoppage of growth of the scale.

When the scale is examined under the microscope it is seen that there is at the edge a narrow portion which is without concentric ridges or markings of any kind. The anterior portion of the surface of the scale is thrown into folds which are bounded laterally by radiating grooves and are strongly marked off from the narrow zone already mentioned by a curved line more or less parallel with the edge of the scale. Concentric ridges run across the folds, but at the anterior portion of the fold is a small area in which these ridges are not strongly developed. When growth begins again, the anterior curved boundary of the fold persists, and concentric ridges are formed roughly parallel with those of the previous summer. There is therefore formed by the persistence of the anterior boundaries of the folds, which near the long axis of the scale are strongly curved, and by the small area between these boundaries and the last fully developed concentric ridges, a definite marking which serves to indicate the number of winters the fish has lived.

Laterally, the concentric ridges are not parallel with the edge of the scale, but make a small angle with it. When growth stops in winter these ridges likewise stop, and on growth commencing again, lateral concentric ridges are formed parallel to what was the edge of the scale. Therefore, there is in this region of the scale a definite indication of the stoppage in growth, which will be evident in the photograph.

When the scale is expressed in terms of the length of the fish, a size of 3·7 cm. is given for the first year's growth.

The fish was examined 24th May, 1916; the length was 8 cm., and the scales showed growth had not commenced for this year.

Another young ballan wrasse, 1·8 cm. long, was taken in a rock pool, 18th August, 1916. The scales were small and showed from three to five concentric ridges.

An older fish, 27·5 cm., was obtained 9th November, 1915. Scales were examined from different regions of the body, and all gave the same reading for age, except those on which the concentric ridges were absent, about the focus of the scale. There was some difficulty in determining the winters, especially as the concentric ridges in the lateral portions of the scale became more and more parallel with the edge as age advanced. From calculations made the growth for this fish would appear to be as follows :—

Years ...	1	2	3	4	5	6	7	
Size	4·0	9·3	15·1	19·3	22·4	25·3	27·5	cm.

BASS, *Morone labrax.*

The scales of the bass are from the standpoint of age determination very similar to those of the ballan wrasse. There is the same but more strongly marked evidence of stoppage of growth in the area of the radiating grooves, and also in the lateral portions of the scale.

Three specimens have been obtained, and the size, age, date and locality of capture, and rate of growth as obtained by expressing the scale in terms of the length of the fish are as follows :—

Size.	Age.	Date and Locality of Capture.
Cm.		
25·5	3	3rd Feb., 1914. 15 miles N.E. of the Longstone.
34·0	5	13th Nov., 1915. 11 miles N.E. of the Tyne.
41·5	5	18th Nov., 1915. 30 miles N.E. of the Tyne.

Years ...	1	2	3	4	5
Size ...	9·4	18·5	25·5	—	—
	8·9	17·2	26·4	30·8	34·0
	10·1	18·9	27·4	35·2	41·5

COMBER, *Serranus cabrilla.*

One specimen of *Serranus cabrilla*, 22·5 cm. in length, was landed 18th November, 1915, by a North Shields trawler from 30 miles N.E. of the Tyne. The scales have the winters similarly marked to those of the bass and ballan wrasse, and also indicate a complete stoppage of growth during the winter. This stoppage is not so clear in the area occupied by the radiating grooves, but is very strongly marked in the lateral portions of the scales by the condition of the concentric ridges, which are not parallel to the edge of the scale, especially in earlier years, and are interrupted each winter.

Calculations made from the scales give a growth as follows :—

Years	...	1	2	3	4	5	
Size	...	6·3	12·3	18·1	21·6	22·5	cm.

TABLE 1.—Lemon Dab, Size and Age.

Centimetres.

Age.	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	Total.
4	2	1	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	4
5	1	1	2	3	2	5	5	2	—	3	4	—	1	1	1	—	—	—	—	—	—	31
6	—	—	1	1	—	1	4	2	4	1	—	2	2	2	1	—	—	—	—	—	—	21
7	—	—	—	—	—	1	1	2	1	1	1	3	2	2	—	—	—	—	—	—	—	14
8	—	—	—	—	—	—	—	—	—	2	1	2	4	—	1	1	—	—	—	—	—	11
9	—	—	—	—	—	—	—	—	—	—	—	—	1	—	1	—	1	—	—	—	—	3
10	—	—	—	—	—	—	—	—	—	1	1	—	—	1	1	1	1	1	—	—	—	7
11	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	1
12	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	1	—	—	—	—	—	2
13	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	1	—	—	—	—	1	3
14	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2	—	1	—	—	1	—	4
16	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	1
	3	2	3	4	2	7	11	6	5	8	7	7	10	6	9	4	4	2	—	1	1	102

TABLE II.—Lemon Dab, Size and Age (Calculated).

Centimetres.

Age.	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	Total.
1	1	5	12	21	10	5	5	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	60
2	—	—	—	—	—	—	4	1	12	10	11	7	5	3	4	1	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	60
3	—	—	—	—	—	—	—	—	—	—	—	1	1	4	10	3	11	8	7	1	4	4	2	1	2	—	1	—	—	—	—	—	—	—	—	60
4	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	1	4	6	5	2	13	6	7	3	3	4	3	1	—	—	1	—	—	—	60
5	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	2	1	2	6	6	5	8	4	4	4	3	—	1	1	1	49
6	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	4	3	2	1	5	1	2	2	—	—	21
7	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	1	—	5	1	—	1	1	10.

TABLE III.—Dab.

Centimetres.

Age.	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	Total.
2	2	8	22	30	20	23	15	5	—	1	—	—	—	—	—	—	—	—	126
3	—	—	—	7	11	24	19	33	25	22	15	15	8	4	2	1	—	—	186
4	—	—	—	—	—	—	—	—	5	4	7	7	15	3	4	2	4	1	52
5	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	3	1	5
	2	8	22	37	31	47	34	38	30	27	22	23	23	7	6	3	7	2	369

TABLE IV.—Plaice.

Centimetres.

Age.	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	Total.
2	—	1	4	3	5	7	6	3	1	1	—	—	—	—	—	—	—	—	31
3	—	—	—	1	1	4	4	8	8	4	9	3	5	4	1	—	1	—	53
4	—	—	—	—	—	—	—	—	—	—	—	2	3	—	2	1	1	—	9
5	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	1	—	2
	—	1	4	4	6	11	10	11	9	5	9	5	8	5	3	1	3	—	95

TABLE V.—Young Plaice and Turbot.

Size in Centimetres.

	24 Aug.	4 Oct.	1 Nov.	2 Dec.	5 Jan.	1 Feb.	7 March	7 April.	19 May.	19 June.
Plaice ...	3·0	3·5	4·0	4·2	4·2	4·3	4·4	—	—	—
	3·4	3·9	4·2	4·6	4·9	5·0	5·1	5·2	5·3	5·9
	3·4	3·9	4·2	4·8	5·1	5·5	5·7	5·8	5·9	6·6
	3·4	3·9	4·5	5·0	5·1	5·8	6·2	6·5	6·9	7·4
	3·5	4·0	4·7	—	—	—	—	—	—	—
	3·5	4·2	4·8	5·1	5·3	6·0	6·5	6·6	7·2	8·1
	3·6	4·2	4·9	5·4	5·6	6·1	6·5	6·7	7·4	8·3
	3·6	4·2	5·0	5·6	5·7	6·3	6·5	6·8	7·6	8·6
	3·7	4·4	5·1	5·9	—	—	—	—	—	—
	3·8	4·5	5·5	6·2	6·3	6·8	7·1	7·3	7·7	9·1
	3·8	4·5	5·6	6·2	6·4	6·9	7·5	7·8	8·9	9·1
	4·0	4·6	5·9	6·5	6·9	7·7	8·2	8·5	9·1	9·9
	4·0	4·6	6·0	6·5	6·9	8·0	8·5	9·0	—	—
	4·3	5·0	6·0	6·8	7·0	8·0	8·8	9·4	9·9	10·1
	4·3	5·0	6·5	7·2	—	—	—	—	—	—
	4·7	5·4	6·7	7·4	7·7	8·7	9·0	9·5	10·0	11·1
	4·9	5·5	6·9	7·6	8·3	9·3	9·6	9·9	10·6	11·5
	5·0	6·0	7·3	8·1	8·5	9·3	9·9	10·5	11·2	11·9
	5·0	6·0	7·7	8·4	9·2	9·8	10·3	10·5	11·8	12·9
	5·2	6·3	7·8	8·8	9·5	10·5	11·4	11·8	12·6	13·4
Turbot ...	3·3	4·3	4·8	4·8	4·8	4·8	4·9	5·0	5·4	5·8
	4·4	6·0	6·6	6·8	6·4*	6·7	—	—	—	—
	4·7	6·2	7·1	7·2	—	—	—	—	—	—
	4·9	6·3	7·3	7·4	7·4	7·4	7·4	7·5	8·0	8·5
	5·9†	6·7	7·3	7·4	7·4	7·4	7·5	7·6	8·4	9·1

* Deformed through being caught in overflow.

† Put into tank 23rd September.

FIGURE 1.

FIGURE 2.

PLATE I.—SCALES OF LEMON DAB.

Figure 1.—Caught 17th April, 1916, 23·8 cm., 4th summer's growth begun.
„ 2.—Caught 1st April, 1916, 41·5 cm., 9 summer areas.

FIGURE 1.—OTOLITH OF HALIBUT,
61 cm., 10th April, 1916.

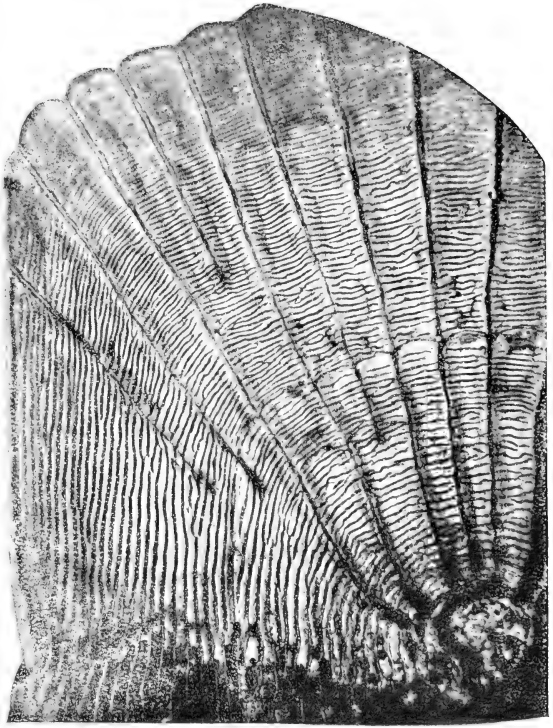


FIGURE 2.—PART OF SCALE OF BALLAN WRASSE,
8 cm., 17th January, 1916.

PLATE II.

FAUNISTIC NOTES.

By B. STORROW.

Acanthias vulgaris.—During the latter part of 1915, and especially in October, large quantities of dog fish were landed at North Shields. Most of them were caught about 70 miles N.E. by E. of the Tyne ; smaller numbers came from the North East Bank, and still smaller numbers from nearer the coast. On 13th October, a number of females were examined for eggs, but these had not developed. A general impression was formed that the males were more numerous than the females, and were of larger size. To test this, two heaps of dogfish, which had been caught 70 miles N.E. by E. of the Tyne, were taken indiscriminately from the fish quay and examined on 18th October, and gave the following result :—

MALES ...	Size ...	24	25	26	27	28	29	30	31			cm.
	Nos. ...	2	1	8	13	17	6	2	1			=50
FEMALES ...	Size ...	20	21	22	23	24	25	26	27	28		cm.
	Nos. ...	1	—	3	1	5	1	—	—	1		=12

Thunnus thynnus.—A tunny, 8 feet 6 inches long, was found on the sands to the north of Whitley Bay, 4th December, 1915. The fish was a male, and from the condition of the gonads had recovered after spawning, but had not commenced to prepare for the next spawning. There were no signs of external injury, and the internal organs were all in a healthy condition. The fish was quite fresh, and some of the flesh was taken and found to be delicious. In the posterior part of the intestine, about 8 or 9 inches from the anus, was a large double hook, about $4\frac{1}{4}$ inches long and $1\frac{1}{2}$ inches between the points and the shaft.

Cantharus griseus.—A specimen of the black sea bream, 40 cm. long, was obtained November, 1911, from a North Shields trawler, which had been fishing on the local Prawn Ground. No record of this fish was given in the Report for that year.

Argentina silus.—Small quantities of this fish have been landed at North Shields during the latter part of June and the beginning of July by trawlers which have been fishing about 180 miles N.E. of the Tyne, in depths varying from 46 to 71 fathoms.